Method for refining of aqueous suspended paper or pulp fibers

The invention relates to a method in accordance with the generic term of claim 1.

It has been known for a long time that pulp fibers must be refined so that the subsequently produced paper possesses the desired characteristics, especially strength, formation and surface. The most commonly used refining methods utilize refining surfaces that are equipped with refiner bars. The appropriate machines are usually referred to as bar refiners. For special applications refining processes are also used where at least one refiner surface is knife (bar) free, so that the refining action is transferred through friction or shear forces.

The effect of the process can be controlled within a wide range by changing the refining parameters, whereby in addition to the height of the refining level it can be especially distinguished whether a stronger cutting or stronger fibrillated refining is desired. If pulp fibers are being processed by means of the known refining processes, then their dewatering resistance increases with increasing refining level. A common measure for the dewatering resistance is the freeness according to Schopper-Riegler.

An increase in the freeness value negatively affects the sheet formation in the paper machine. It is however accepted since the already mentioned quality characteristics of the pulp play a predominant role for its usability. In many instances the refining parameters are selected so that the refining value increase that is required to achieve the desired fiber quality is as low as possible. This sphere of influence is however very limited. In addition, this may adversely affect the power efficiency of the refining process.

DE 894 499 describes a refining apparatus comprising a rotating refiner cylinder against whose inside wall several refiner rolls are pressed in order to refine the

pulp. The refiner rolls are equipped with special circumferential grooves in order to achieve a certain desired refining effect. The refiner is not equipped for continuous operation.

It is therefore the purpose of the current invention to create a continuously operating method with which pulp or paper fibers may be refined such that the strength properties of the hereby produced paper are increased. The increased dewatering resistance occurring during this process should be at least less than with known refining methods. The desired apparatus should be suitable to be utilized for the production of paper on an industrial level.

This objective is met by the characteristics cited in claim 1.

Most of the known refiner drums are not suitable for this purpose since their effectiveness is based on breaking of coarse particles. US 2,719,463 for example, describes a refiner cylinder which can be utilized in the paper manufacturing industry, however for processing of the associated relatively coarse reject material. An apparatus of this type targets the size reduction of contaminants and is intended to leave the fibers which are contained in the reject unaltered.

The new refining process operates in a way that the fiber characteristics are optimized, whereby the desired strength properties are developed without the freeness value being increased as is inherent with the conventional method.

Comparative tests with long fiber pulp have demonstrated that, in order to achieve a tear length of 8 km with a bar type refining process, a 45° SR freeness value resulted, but only

18° SR with the new method. The required specific refining labor was lower by up to 50%.

It may be assumed that the structure of the fiber wall and the surface of the fibers are altered by the new refining method to such an extent that it contains an improved flexibility and bonding capability, without having to remove fibrils from the outer surface of the fibers. In addition, the production of fines – that is fiber fragments – is very limited.

If the method is used for recycled fibers, the advantages cited under 1 and 2 may play a special role. Recycled fibers have already undergone at least one, and many times several refining actions so that avoiding any further size reduction is welcome.

The current invention and its advantages are described in further detail by the drawings:

Fig. 1 an example for the realization of the inventive method with the assistance of a refining cylinder;
Fig. 2 detail, showing a refining roll according to Fig. 1;
Fig. 3 side view of a refiner apparatus suitable for the method – with removed refining rolls;
Fig. 4 a component for the axial transportation of the fibrous stock
Fig. 5 an additional design example with altered flow direction;
Fig. 6 detail of a refining roll according to Fig. 5;
Fig. 7 an additional design example with shorter refining rolls;
Fig. 8 an example with a conical refining drum.

The refiner depicted in Fig. 1 illustrates a refiner cylinder 1 in horizontal position, equipped with several refiner rolls 2, located uniformly around its the circumference. This illustration depicts five refiner rolls 2. In total there are 8. The refiner rolls are each equipped with a larger number of refiner bars 3, which can also be referred to as knives. The refiner bars 3 and the surfaces of the refiner cylinder 1 which are in contact with the stock may consist of a material that is commonly used for this type of application (for example hardened cast chromium steel), or of a porous material, for example sintered chromium steel. When realizing the method, a refining zone is formed between the refiner roll 2 and the refiner cylinder 1 at the position where the inside wall of the refiner cylinder 1 and the refiner bars 3 are closest to each other. The refiner rolls 2 are pressed in radial direction against the inside wall of the refiner cylinder 1 in order to generate the necessary refining force. For this purpose spring 6 is indicated in the example in the drawing. Obviously other types of pressure generating systems, for example a pneumatic or hydraulic pressure cylinder may also be used. The refiner rolls 2 are mounted to rotate on a stationary axis of rotation. They may for example be fixed through two supports 7 which extend in axial direction into the refiner cylinder. The refiner cylinder 1 is brought into rotation by a drive roller 4. Other drive possibilities however, are also feasible. The refiner rolls 2 do not require their own drive, since they are brought into rotation on the inside wall of the refiner cylinder 1. This represents a substantial simplification of the refiner apparatus.

The aqueous suspended paper fibers are brought into the vicinity of the inside wall through one or several pipe lines 9. A pipe line 9 of this type is drawn schematically in a location where, for reasons of clarity, the refiner rolls are not depicted. Due to the rotational motion of the refiner cylinder 1 the aqueous suspended paper fibers attach themselves in the form of a fibrous stock layer 8 to the inside wall of said refiner cylinder 1. Since the pipe line 9, as well as the support 7 are stationary it is easily possible to

supply the pipelines 9 centrally from the support 7 with suspension S. The fibrous stock suspension S flowing from the pipeline 9 is being accelerated in circumferential direction and distributes itself on the inside wall of the refiner cylinder 1. It then enters a refining zone which is formed between a refiner roll 2 that is equipped with refiner bars 3. and the inside wall of the refiner cylinder 1. It is normally desirable that the fibrous stock suspension be run through refining zones several times: Due to the centrifugal forces inside the refiner cylinder 1, a relatively uniform thickness is achieved for the fibrous stock layer 8. As illustrated in Fig. 2 the refined fibrous stock suspension S' can be discharged through an outlet opening 10 on the circumference of the refiner cylinder 1. It is discharged through a sealing element 11 into a stationary ring channel 12. Sealing element 11 or ring channel 12 can be designed so that a connection to the ring channel 12 exists only in a limited section of the circumference. In order to ensure a defined thickness of the fibrous stock layer 8 around the refiner cylinder 1 a back pressure can be created in the ring channel 12. In the upper section of the refiner cylinder 1 the drawing depicts an example of a cross bar 14 on which a number of guide vanes 15 are mounted. These dip into the fibrous stock layer 8 and lead to a defined axial transportation. We will make further reference to the axial transportation later.

The refiner bars 3 will generally be arranged parallel to the axis. It is however also feasible that they are positioned in sharp angle α relative to the center line of the refiner roll 2 in order to promote for example, the axial transportation of the fibrous stock suspension. Both these possibilities are indicated on a single refiner roll 2 in Fig. 2.

Fig. 3 illustrates a side view of a refiner suitable for realizing the method. It comprises of a refiner cylinder 1 in horizontal position. Several supports 5 can also be seen. However, the refiner rolls are not illustrated. In order to achieve a stock transportation that is as

uniform as possible, the fibrous stock is directed in axial direction from one face 13 of the refiner cylinder 1 to the opposite side. The supply through the pipe line 9 is shown on the right in this drawing. The discharge through a ring channel 12 is on the left. Near the inside wall of the refiner cylinder 1 one or several stationary cross bars 14 with guide vanes 15 are located. As illustrated in Fig. 4, the guide vanes 15 are angled relative to the circumferential direction 16 which results in an axial offset 17 of the fibrous suspension S. One or several doctor bars 14' can also be used to lift the fibrous stock layer 8 from the inside wall of the refiner cylinder 1, loosen it and move it in axial direction by means of guide vanes 15' which are mounted on the opposite side.

The refiner illustrated in Fig. 5 also shows a refiner cylinder 1 in horizontal position on which several refiner rolls 2' are positioned uniformly across the circumference. This illustration depicts three of a total of ten refiner rolls 2' whose length is slightly shorter than half of the axial length of the refiner cylinder 1 (s. Fig. 7). The means to drive the refiner cylinder 1 and to generate the refining force are similar or identical to those already described in Fig. 1. The refiner rolls 2' rotate on a stationary rotational axis. They may for example be cantilevered in a support 6 which is mounted on a yoke 19 that extends through the refiner cylinder in axial direction.

The aqueous suspended paper fibers are fed into the refiner, as already described under Fig. 1, where they are distributed and treated. In order to produce a continuously uniform suspension stream it is advantageous to provide overflow openings 20 in one, or preferably both faces 23 of the refiner cylinder 1. The overflow openings 20 can be distributed equally around the circumference. As is the case with a weir, their radial distance from the inside wall of the refiner cylinder 1 essentially determines the height with which the liquid layer 8 can develop. As shown in Fig. 6, the refined fibrous stock suspension S' can be discharged through a sealing element 21 into a stationary ring

channel 22. The sealing element 21 can be designed so that there is a connection with the ring channel 22 only in a limited section of the circumference, for example immediately before the location where pipeline 9 discharges. In order to decrease the cost of the relatively large sealing element 21 an also rotating line which is not depicted here could of course transport the refined fibrous stock to a location that could be sealed more easily.

The refiner bars 3 will generally be located parallel to the axis. It is however also feasible that they are positioned in sharp angle α relative to the center line of the refiner roll 2' in order to promote for example, the axial transportation of the fibrous stock suspension. Both these possibilities are indicated on a single refiner roll 2' in Fig. 6.

Fig. 7 shows a side view of the refiner depicted in Fig. 5. It comprises a horizontally positioned refiner cylinder 1. It is shown that two refiner rolls 2' respectively are mounted cantilevered in a support 5. This promotes a simple design with few components that could interfere with the suspension flow. In addition, the axial extension of the refiner rolls 2' can be kept relatively short. This also contributes to a uniform refining of the fibers. The addition of the fibrous stock suspension S occurs here through two axially distanced pipelines 9.

In contrast to what has been shown previously, the axial transportation in the refiner drum can also be improved in certain design forms in that a conical refiner drum 18, as illustrated schematically in Fig. 8, is utilized. Relative to the axial direction its inside wall has an inclined angle β which is preferably smaller than 5°. Due to the centrifugal forces during rotation of the refiner cylinder, an accordingly usable axial force component is created. Based on these steps the stationary transport elements such as the cross bar 14 or doctor bar 14' which are depicted in Fig. 1, 3 or 4 may possibly be eliminated.